Instructions: Legibly complete each of the following on lined paper and submit on Gradescope.

1. Using the dictionary below, translate the following English statements into the formal propositional language.

   A : Amy can pitch a tent.
   B : Amy can go camping.
   C : Amy likes to go fishing.
   D : Amy knows how to build a campfire.

   (a) If Amy can pitch a tent, then she can go camping.
   (b) If Amy likes to go fishing, then she knows how to build a campfire but cannot go camping.
   (c) If Amy does not know how to build a campfire but can pitch a tent, then either Amy does not like to fish or she can go camping.

2. Using the dictionary from Question 1, translate the following formal statements into English.
   (a) $A \to (B \vee (\neg C))$
   (b) $A \leftrightarrow D$
   (c) $(A \wedge (\neg C)) \vee (C \wedge (\neg B))$

3. Create a truth table for each of the following statements.

   (a) $(p \to q) \to (q \to p)$
   (b) $(q \leftrightarrow (\neg p)) \vee p$
   (c) $((p \to q) \wedge p) \leftrightarrow (\neg q)$
   (d) $(p \wedge (\neg q)) \vee (r \to q)$

4. Compute the disjunctive normal form (DNF) of each statement from Question 3.

5. Show each of the following logical equivalences via the definition of logical equivalence.

   (a) $(p \to q) \wedge (p \to r) \equiv p \to (q \wedge r)$
   (b) $(p \to r) \wedge (q \to r) \equiv (p \vee q) \to r$

6. Show each logical equivalence of question 5 via the algebra of statements.

7. Is $p \to (q \to r)$ logically equivalent to $(p \to q) \to r$? Give a full justification of your answer.

8. Use natural deduction to show each of the following argument forms is valid. Use the 2-column proof style from class, justifying each step completely via a basic logical equivalence or an argument form from lecture.
   (a) $x \to (x \to (\neg y))$, $y \vee (\neg t)$, x , $w \to t$ $\therefore \neg w$
   (b) $x \to y$, $((\neg x) \vee w) \to k$, $(\neg y) \wedge z$ $\therefore k \vee t$
   (c) $(x \wedge y) \vee (z \wedge w)$, $(x \wedge y) \to l$, $(\neg l) \wedge m$, $z \to (n \wedge o)$ $\therefore n$
   (d) $\neg(x \wedge y)$, x , $y \vee z$ $\therefore z$
   (e) x , $(y \to x) \to z$ $\therefore x \wedge z$
   (f) $x \to z$, $y \to z$ $\therefore (x \vee y) \to z$
   (g) $\neg(x \vee (\neg x))$ $\therefore y$